2008. Growth should be strongest in State and local governments and in research and testing services, where demand will be spurred by a continuing emphasis on environmental protection and responsible land management. Job opportunities are expected to be best for soil conservationists and other conservation scientists as government regulations, such as those regarding the management of stormwater and coastlines, has created demand for persons knowledgeable about erosion on farms and in cities and suburbs. Soil and water quality experts will also be needed as States attempt to improve water quality by preventing pollution by agricultural producers and industrial plants.

Fewer opportunities for conservation scientists and foresters are expected in the Federal Government, partly due to budgetary constraints. Also, Federal land management agencies, such as the Forest Service, have de-emphasized their timber programs and increasingly focused on wildlife, recreation, and sustaining ecosystems, thereby increasing demand for other life and social scientists relative to foresters. However, a large number of foresters are expected to retire or leave the Government for other reasons, resulting in some job openings between 1998 and 2008. In addition, a small number of new jobs will result from the need for range and soil conservationists to provide technical assistance to owners of grazing land through the Natural Resource Conservation Service.

The recent reductions in timber harvesting on public lands, most of which are located in the Northwest and California, also will dampen job growth for private industry foresters in these regions. Opportunities will be better for foresters in the Southeast, where much forested land is privately owned. Rising demand for timber on private lands will increase the need for forest management plans that maximize production while sustaining the environment for future growth. Salaried foresters working for private industry—such as paper companies, sawmills, and pulp wood mills—and consulting foresters will be needed to provide technical assistance and management plans to landowners.

Research and testing firms have increased their hiring of conservation scientists and foresters in recent years in response to demand for professionals to prepare environmental impact statements and erosion and sediment control plans, monitor water quality near logging sites, and advise on tree harvesting practices required by Federal, State, or local regulations. Hiring in these firms should continue during the 1998-2008 period, though at a slower rate than over the last ten years.

Earnings

Median annual earnings of conservation scientists and foresters in 1998 were $42,750. The middle 50 percent earned between $34,150 and $51,550. The lowest 10 percent earned less than $26,330 and the highest 10 percent earned more than $75,330. Median annual earnings of conservation scientists and foresters employed in State governments in 1997 were $37,400.

In 1999, most bachelor's degree graduates entering the Federal Government as foresters, range managers, or soil conservationists started at $20,600 or $25,500, depending on academic achievement. Those with a master's degree could start at $25,500 or $31,200. Holders of doctorates could start at $37,700 or, in research positions, at $45,200. Beginning salaries were slightly higher in selected areas where the prevailing local pay level was higher. In 1999, the average Federal salary for foresters in nonsupervisory, supervisory, and managerial positions was $51,000; for soil conservationists, $48,900; for rangeland managers, $46,300, and for forest products technologists, $68,300.

According to the National Association of Colleges and Employers, graduates with a bachelor's degree in natural resources received an average starting salary offer of $26,100 in 1999.

In private industry, starting salaries for students with a bachelor's degree were comparable to starting salaries in the Federal Government, but starting salaries in State and local governments were usually lower.

Conservation scientists and foresters who work for Federal, State, and local governments and large private firms generally receive more generous benefits than those working for smaller firms.

Related Occupations

Conservation scientists and foresters manage, develop, and protect natural resources. Other workers with similar responsibilities include agricultural scientists, agricultural engineers, biological scientists, environmental scientists and engineers, farm and ranch managers, and wildlife managers.

Sources of Additional Information

For information about the forestry profession and lists of schools offering education in forestry, send a self-addressed, stamped business envelope to:

☛ Society of American Foresters, 5400 Grosvenor Ln., Bethesda, MD 20814. Internet: **http://www.safnet.org**

For information about career opportunities in forestry in the Federal Government, contact:

☛ Chief, U.S. Forest Service, U.S. Department of Agriculture, P.O. Box 96090, SW., Washington, DC 20090-6090.

For information about a career in State forestry organizations, contact:

☛ National Association of State Foresters, 444 N. Capitol St. NW., Suite 540, Washington, DC 20001.

Information about a career as a range manager as well as a list of schools offering training is available from:

☛ Society for Range Management, 445 Union Blvd., Suite 230, Lakewood, CO 80228-1259. Internet: **http://srm.org**

Physical Scientists

Atmospheric Scientists

(O*NET 24108)

Significant Points

- The Federal Government employs more than 1 out of 3 meteorologists and is their largest employer.
- A bachelor's degree in meteorology, or in a closely related field with courses in meteorology, is the minimum educational requirement; a master's degree is necessary for some positions, and a Ph.D. is required for most research positions.
- Applicants may face competition if the number of degrees awarded in atmospheric science and meteorology remain near current levels.

Nature of the Work

Atmospheric science is the study of the atmosphere—the blanket of air covering the Earth. Atmospheric scientists, commonly called meteorologists, study the atmosphere's physical characteristics, motions, and processes, and the way it affects the rest of our environment. The best known application of this knowledge is in forecasting the weather. However, weather information and meteorological research are also applied in air-pollution control, agriculture, air and sea transportation, defense, and the study of trends in Earth's climate such as global warming, droughts, or ozone depletion.

Atmospheric scientists who forecast the weather, known professionally as *operational meteorologists*, is the largest group of specialists. They study information on air pressure, temperature, humidity, and wind velocity; and apply physical and mathematical relationships to make short- and long-range weather forecasts. Their data come from weather satellites, weather radars, and sensors and observers in many parts of the world. Meteorologists use sophisticated computer models of the world's atmosphere to make long-term, short-term, and local-area forecasts. These forecasts inform not only the general public, but also those who need accurate weather information for both economic and safety reasons, as in the shipping, air transportation, agriculture, fishing, and utilities industries.

The use of weather balloons, launched a few times a day to measure wind, temperature, and humidity in the upper atmosphere, is currently supplemented by sophisticated atmospheric monitoring equipment that transmits data as frequently as every few minutes. Doppler radar, for example, can detect airflow patterns in violent storm systems—allowing forecasters to better predict tornadoes and other hazardous winds, as well as to monitor the storm's direction and intensity. Combined radar and satellite observations allow meteorologists to predict flash floods.

Some atmospheric scientists work in research. *Physical meteorologists*, for example, study the atmosphere's chemical and physical properties; the transmission of light, sound, and radio waves; and the transfer of energy in the atmosphere. They also study factors affecting the formation of clouds, rain, snow, and other weather phenomena, such as severe storms. *Synoptic meteorologists* develop new tools for weather forecasting using computers and sophisticated mathematical models. *Climatologists* collect, analyze, and interpret past records of wind, rainfall, sunshine, and temperature in specific areas or regions. Their studies are used to design buildings, plan heating and cooling systems, and aid in effective land use and agricultural production. Other research meteorologists examine the most effective ways to control or diminish air pollution.

Working Conditions

Most weather stations operate around the clock 7 days a week. Jobs in such facilities usually involve night, weekend, and holiday work, often with rotating shifts. During weather emergencies, such as hurricanes, operational meteorologists may work overtime. Operational meteorologists are also often under pressure to meet forecast deadlines. Weather stations are found all over—at airports, in or near cities, and in isolated and remote areas. Some atmospheric scientists also spend time observing weather conditions and collecting data from aircraft. Weather forecasters who work for radio or television stations broadcast their reports from station studios, and may work evenings and weekends. Meteorologists in smaller weather offices often work alone; in larger ones, they work as part of a team. Meteorologists not involved in forecasting tasks work regular hours, usually in offices. Those who work for private consulting firms or for companies analyzing and monitoring emissions to improve air quality usually work with other scientists or engineers.

Atmospheric scientists who forecast the weather are known as operational meteorologists.

Employment

Atmospheric scientists held about 8,400 jobs in 1998. The Federal Government is the largest single employer of civilian meteorologists. The National Oceanic and Atmospheric Administration (NOAA) employed about 2,600 meteorologists; nearly 90 percent worked in the National Weather Service at stations throughout the Nation. The remainder of NOAA's meteorologists worked mainly in research and development or management. The Department of Defense employed about 280 civilian meteorologists. Others worked for research and testing services, private weather consulting services, and computer and data processing services.

Although several hundred people teach atmospheric science and related courses in college and university departments of meteorology or atmospheric science, physics, earth science, and geophysics, these individuals are classified as college or university faculty, rather than atmospheric scientists. (See the statement on college and university faculty elsewhere in the *Handbook*.)

In addition to civilian meteorologists, hundreds of Armed Forces members are involved in forecasting and other meteorological work. (See the statement on job opportunities in the Armed Forces elsewhere in the *Handbook*.)

Training, Other Qualifications, and Advancement

A bachelor's degree in meteorology or atmospheric science, or in a closely related field with courses in meteorology, is usually the minimum educational requirement for an entry-level position as an atmospheric scientist.

The preferred educational requirement for entry-level meteorologists in the Federal Government is a bachelor's degree—not necessarily in meteorology—but with at least 24 semester hours of meteorology courses, including 6 hours in the analysis and prediction of weather systems and 2 hours of remote sensing of the atmosphere or instrumentation. Other required courses include differential and integral calculus, differential equations, 6 hours of college physics, and at least 9 hours of courses appropriate for a physical science major—such as statistics, computer science, chemistry, physical oceanography, or physical climatology. Sometimes, a combination of experience and education may be substituted for a degree.

Although positions in operational meteorology are available for those with only a bachelor's degree, obtaining a master's degree enhances employment opportunities and advancement potential. A master's degree is usually necessary for conducting applied research and development, and a Ph.D. is required for most basic research positions. Students planning on a career in research and development need not necessarily major in atmospheric science or meteorology as an undergraduate. In fact, a bachelor's degree in mathematics, physics, or engineering provides excellent preparation for graduate study in atmospheric science.

Because atmospheric science is a small field, relatively few colleges and universities offer degrees in meteorology or atmospheric science, although many departments of physics, earth science, geography, and geophysics offer atmospheric science and related courses. Prospective students should make certain that courses required by the National Weather Service and other employers are offered at the college they are considering. Computer science courses, additional meteorology courses, a strong background in mathematics and physics, and good communication skills are important to prospective employers. Many programs combine the study of meteorology with another field, such as agriculture,

oceanography, engineering, or physics. For example, hydrometeorology is the blending of hydrology (the science of Earth's water) and meteorology, and is the field concerned with the effect of precipitation on the hydrologic cycle and the environment. Students who wish to become broadcast meteorologists for radio or television stations should develop excellent communication skills through courses in speech, journalism, and related fields. Those interested in air quality work should take courses in chemistry and supplement their technical training with coursework in policy or government affairs.

Beginning atmospheric scientists often do routine data collection, computation, or analysis, and some basic forecasting. Entry-level operational meteorologists in the Federal Government are usually placed in intern positions for training and experience. During this period, they learn about the Weather Service's forecasting equipment and procedures, and rotate to different offices to learn about various weather systems. After completing the training period, they are assigned a permanent duty station. Experienced meteorologists may advance to supervisory or administrative jobs, or may handle more complex forecasting jobs. After several years of experience, some meteorologists establish their own weather consulting services.

The American Meteorological Society offers professional certification of consulting meteorologists, administered by a Board of Certified Consulting Meteorologists. Applicants must meet formal education requirements (though not necessarily have a college degree), pass an examination to demonstrate thorough meteorological knowledge, have a minimum of 5 years of experience or a combination of experience plus an advanced degree, and provide character references from fellow professionals.

Job Outlook

Employment of atmospheric scientists is projected to increase about as fast as the average for all occupations through 2008, and prospective atmospheric scientists may face competition if the number of degrees awarded in atmospheric science and meteorology remain near current levels. The National Weather Service (NWS) has completed an extensive modernization of its weather forecasting equipment and finished all hiring of meteorologists needed to staff the upgraded stations. The NWS has no plans to increase the number of weather stations or the number of meteorologists in existing stations for many years. Employment of meteorologists in other Federal agencies is expected to decline slightly as the Federal Government attempts to balance its budget.

On the other hand, job opportunities for atmospheric scientists in private industry are expected to be better than in the Federal Government over the 1998-2008 period. As research leads to continuing improvements in weather forecasting, demand should grow for private weather consulting firms to provide more detailed information than has formerly been available, especially to weather-sensitive industries. Farmers, commodity investors, radio and television stations, and utilities, transportation, and construction firms can greatly benefit from additional weather information more closely targeted to their needs than the general information provided by the National Weather Service. Additionally, research on seasonal and other long-range forecasting is yielding positive results, which should spur demand for more atmospheric scientists to interpret these forecasts and advise weather-sensitive industries. However, because many customers for private weather services are in industries sensitive to fluctuations in the economy, the sales and growth of private weather services depend on the health of the economy.

There will continue to be demand for atmospheric scientists to analyze and monitor the dispersion of pollutants into the air to ensure compliance with Federal environmental regulations outlined in the Clean Air Act of 1990, but employment increases are expected to be small.

Earnings

Median annual earnings of atmospheric scientists in 1998 were $54,430. The middle 50 percent earned between $38,570 and $75,260. The lowest 10 percent earned less than $27,250 and the highest 10 percent earned more than $87,760.

The average salary for meteorologists in nonsupervisory, supervisory, and managerial positions employed by the Federal Government was about $62,500 in 1999. Meteorologists in the Federal Government with a bachelor's degree and no experience received a starting salary of $20,600 or $25,500, depending on their college grades. Those with a master's degree could start at $25,500 or $31,200; those with the Ph.D., at $37,700 or $45,200. Beginning salaries for all degree levels are slightly higher in selected areas of the country where the prevailing local pay level is higher.

Related Occupations

Workers in other occupations concerned with the physical environment include oceanographers, geologists and geophysicists, hydrologists, physicists, mathematicians, and civil, chemical, and environmental engineers.

Sources of Additional Information

Information about careers in meteorology is available from:

☛ American Meteorological Society, 45 Beacon St., Boston, MA 02108. Internet: **http://www.ametsoc.org/AMS**

Information on acquiring a job as a meteorologist with the Federal Government may be obtained from the Office of Personnel Management through a telephone-based system. Consult your telephone directory under U.S. Government for a local number or call (912) 757-3000 (TDD 912 744-2299). That number is not toll-free and charges may result. Information also is available from their Internet site: **http://www.usajobs.opm.gov**

Chemists

(O*NET 24105)

Significant Points

- A bachelor's degree in chemistry or a related discipline is usually the minimum educational requirement; however, many research jobs require a Ph.D.
- Job growth will be concentrated in drug manufacturing and research and testing services firms.

Nature of the Work

Everything in the environment, whether naturally occurring or of human design, is composed of chemicals. Chemists search for and put to use new knowledge about chemicals. Chemical research has led to the discovery and development of new and improved synthetic fibers, paints, adhesives, drugs, cosmetics, electronic components, lubricants, and thousands of other products. Chemists also develop processes that save energy and reduce pollution, such as improved oil refining and petrochemical processing methods. Research on the chemistry of living things spurs advances in medicine, agriculture, food processing, and other fields.

Chemists apply their knowledge of chemistry in various ways. Many work in research and development (R&D). In basic research, chemists investigate properties, composition, and structure of matter and the laws that govern the combination of elements and reactions of substances. In applied research and development, they create new products and processes or improve existing ones, often using knowledge gained from basic research. For example, synthetic rubber and plastics resulted from research on small molecules